A Database Prototype Has Been Developed to Help Understand Costs in Photovoltaic Systems

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Abstract

High photovoltaic (PV) system costs hinder market growth. An approach to studying these costs has been developed using a database containing system, component and maintenance information. This data, which is both technical and non-technical in nature, is to be used to identify trends related to costs. A pilot database exists at this time and work is continuing. The results of this work may be used by the data owners to improve their operations with the goal of sharing non-attributable information with the public and industry at large.

The published objectives of the DOE PV program are to accelerate the development of PV as a national and global energy option, as well as ensure U.S. technology and global market leadership. Our approach to supporting these objectives is to understand what drives costs in PV applications. This paper and poster session describe work-in-progress in the form of a database that will help identify costs in PV systems.

In an effort to address DOE's Five-Year PV Milestones, a program was established in the summer of 1999 to study system costs in three PV applications - solar home lighting, water pumping, and grid-tied systems. This work began with a RFQ requesting data from these types of systems. Creating a partnership with industry and other system organizations such as Non-Government Organizations (NGOs) was the approach chosen to maintain a close tie to the systems in the field. Nine participants were selected as partners, who provided data on their systems. Two activities are emphasized in this work. For the first, an iterative approach of developing baseline reliability[1] and costs information with the participants was taken. This effort led to identifying typical components in these systems as well as the specific data (metrics) that would be needed in any analysis used to understand total systems costs. This data came to be defined in terms of system characteristics and component attributes in addition to how and why the system failed. The second major effort, which is still in progress, is the creation of a relational database for storage, review and analysis of this data. A database model was created using the following database requirements as a framework for present and future use:

- Modular structure to support future additions
- Each System has one owner
- Make simple associations at the component level
- Allow multiple components to be tracked with a system
- Allow multiple failures to be documented as a result of a maintenance visit

and future additions are expected to be:

- New applications and/or components
- Inspections to be documented for a system
- Owner may be associated with more than one system
- System may be associated with more than one owner
- Track history of specific system
- Spanish language version

[1] Here reliability is used in a 'soft' interpretation of the definition. The initial analysis is expected to provide trend information and set in place efforts to provide more accurate information for future studies.

The cost drivers in these systems are technical as well as non-technical in nature. Technical costs include system design, installation, maintenance and component design. Was the system well-designed given state-of-the-art practices for this application? Anecdotal stories circulate describing installations by the inexperienced. Can these problems be identified using available data? Maintenance includes the results of not maintaining a system as well as providing incorrect care. In addition, fielded systems show some components perform better than others. Can quantitative support for this experience be developed? A substantial effort was taken to define categories of how a system failed. This work relied on the experience of the nine participants in the study with the realization that these definitions and categories will evolve as our experience with the data increases. The non-technical issues are sometimes described as institutional in nature. In some applications such as solar home lighting, experience has shown these issues can dominate system costs. Education, training, usage patterns, gender and customs create a collection of problems that can sometimes overwhelm the technical aspects of fielding the PV system.

At this time a minimum set of metrics is being used in the analysis to identify trends in the data. This data can be summarized as follows:

- System Identification
- System Installation Date
- Date System Failed and Repaired
- Costs (labor, parts, travel)
- Failure Mode
  - What failed?
  - Why did the failure occur?

The most complete data sets are being used at this time in the pilot data analysis. Initial discussions with the data owner(s) have provided a guide to focus the early analysis efforts. As development of the analysis routines proceeds the iterative process of sharing information with the data owners will focus the evolving charts and tables that identify the information needed to understand the costs in these systems. The eventual goal will be to combine information from various applications and provide public information that will help the PV community and yet protect the proprietary interests of all who participate in the project.

A collection of lessons-learned has emerged from the work-in-progress. This experience is non-technical in nature at this time and reflects the difficulty in establishing a useful database. The lessons-learned can be summarized as follows:

- Customer understanding of their systems and feedback are critical to helping minimize system maintenance
- Data collection is sometimes very difficult-simple worksheets are best because they are used
- Attention to non-technical issues may be important to cost reduction
- Small data sets exist at this time for some partners-there is general interest in developing this information for future collaboration
- Ability to track system history is believed to be valuable for tracking cost contributions
- Additional up-front planning for data collection and sharing reduces effort of translating data for entry into database. Translating data from owner for input to database is tedious and time consuming.

In summary, reducing costs can accelerate the market expansion of PV systems. An approach to studying these costs has been developed using a database containing system, component and maintenance information. This data, which is both technical and non-technical in nature, is to be used to identify trends that help understand costs in the systems. A pilot database exists at this time and work is continuing. The results will be available to data owners to improve their operations with the goal of sharing non-attributable information to the public and industry at large.